DOCUMENT RESUME

ED 123 384 CE 007 120

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TITLE The Construction of a Magnitude Estimation Scale of Adult Learning.
PUB DATE 8 Apr 76
NOTE 36p.; Paper presented at the Adult Education Research Conference (Toronto, Ontario, April 7-9, 1976)

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS Adult Education; *Adult Learning; Adult Students; Analysis of Covariance; *Learning Activities; *Measurement Instruments; Psychophysiology; *Rating Scales; Ratios (Mathematics); Reliability; Research Methodology; Statistical Studies; *Student Opinion

ABSTRACT

The psychophysical technique of magnitude estimation was used to develop a ratio scale of subjective estimations of adult learning in various adult education activities. A rank order of 26 learning activities and the magnitude estimations in "units of learning" that are expected to occur in each activity were obtained from 146 adult education graduate and undergraduate students, 165 participants in a school board adult education evening program and 191 participants in credit courses offered by a community college. Arithmetic and geometric means were computed and plotted for each of the 26 learning activities. Analysis of the results indicates that the magnitudes do constitute a ratio scale. Analysis of covariance revealed age and years of schooling completed to be significant sources of variance on several scale items and sex was found to have a significant effect on one item. Test re-test reliability coefficients with a one month interval between tests, and a cross-modal matching technique with a one week interval between tests indicated the reliability of the instrument. The methodology of the study and the implications of the results for adult education research are discussed. A 14-item bibliography and a copy of the instrument are included. (Author/MS)

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THE CONSTRUCTION OF A MAGNITUDE ESTIMATION SCALE OF ADULT LEARNING

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April 8, 1976

A paper presented at the 1976 A.E.A., Adult Education Research Conference, Toronto, Canada, 7-9 April 1976.

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ABSTRACT

The psychophysical technique of magnitude estimation was used to develop a ratio scale of subjective estimations of adult learning in various adult education activities. Previous research using magnitude estimation procedures has revealed that it is possible to develop ratio scales to quantify certain social norms, opinions and attitudes where judgements indicate how many times greater one situation is than another.

A geometric mean rank order of subjective estimates of learning in twenty-six adult education activities, and the magnitudes of the estimates were obtained from a group of 191 community college participants, 147 members of an adult education department and 165 participants in a school district adult education program. Test re-test reliability coefficients with a one month interval between tests, and a cross-modal matching technique with a one week interval between tests indicated the reliability of the instrument.

The data were analyzed to determine whether the scale possessed ratio characteristics. Linear relationships were noted with regard to the item geometric mean standard errors and increase in subjective estimates, and the ratio of the geometric and arithmetic means and increase in subjective estimates. Evidence of a consensus about the rank ordering of the scale items was found with levels of significance beyond .001 being obtained for Kendal's coefficients of concordance W for each of the three groups. Analysis of covariance revealed age and years of

schooling completed to be significant sources of variance on several scale items and sex was found to have a significant effect on one item.

The methodology followed in the construction and administration of the scale were described and suggestions were made for the implementation of magnitude estimation scaling techniques in adult research.

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INTRODUCTION

Research goals in the emerging discipline of adult education have been primarily concerned with the description and classification of the field and related phenomena.[2] Measurement has been relatively unsophisticated and data has been collected mainly by nominal and ordinal scales. The study of participation for example, has generally relied upon measures that do not relate physical participation to learning and which are not appropriate for sophisticated parametric analysis. The levels of measurement generally used, simply classify types of individuals as participants or non-participants in one or more types of adult education. In rare instances when a more precise measure of participation is sought, indices which may possess the characteristics of an interval measure are developed by means of supposed experts who assess the "educativeness" of various types of participation.

If adult education research is to seek answers to fundamental questions and to investigate the many complex inter-relationships which

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exist in the field, attention must be devoted towards the two highest levels of measurement, interval and ratio scales.

The purpose of this paper is to describe the development of a ratio scale measuring subjective estimates of adult learning. The scale was developed with the following criteria in mind, that it:

1. be appropriate for use in a wide range of settings,
2. be administered simply and quickly,
3. produce a single score indicating the respondent's involvement in adult learning experiences,
4. be appropriate for sophisticated parametric analysis,
5. be capable of distinguishing between various adult education activities by amount of expected learning, and
6. contain a broad range of adult learning activities including (a) those likely to occur in the formal instructional and natural societal settings, (b) credit and non-credit activities, (c) vocational, hobby and general interest learning activities.

SCALE TYPES AND CHARACTERISTICS

Scientific measurement involves the assignment of numbers to observations on the basis of clearly defined rules. Differing means of measurement have been developed in accord with a variety of rules. Stevens[11,12] has identified four broad classes of measurement scales and has specified the mathematical assumptions which govern the

permissible transformations on the scale numbers. The important difference between the four classes of scales is that some are open to more forms of mathematical treatments than are others, and consequently are more desirable in research.

The four classes of scale, from the lowest level of measurement to the highest, are nominal, ordinal, interval and ratio. Nominal scales are used to categorize and classify data such as participants and non-participants, persisters and drop-outs, or researchers and instructors. Ordinal scales enable observations to be ranked or ordered from most to least in terms of the attribute of interest, such as a list of names ordered by distance travelled to attend an adult education centre, or the completion of an assignment. Such measures would reveal who in a class travelled furthest to who travelled the least far, and who in a group finished an assignment from the first person to finish, to the last to finish. No algebraic operations can be conducted with either nominal or ordinal scale data. Neither can ranked data be meaningfully added or subtracted and only on monotonic transformations are ordinal scales invariant. That is a transformation which does not change the order of the observations is allowed, such as changing all twos to fives, threes to eights and fours to nines on a four category scale because no information is lost by such changes.

With interval scaling it is possible to make statements not only about the rank order of observations, but also to state how far apart the observations are on the scale. It is possible therefore to say that a person with an IQ score of 110 is as far above the mean test score of 100 as another individual with a score of 90 is below

the mean. The major difference between the interval and ratio scale is that the ratio scale has an absolute rather than an arbitrary zero enabling observations such as timed performances to be taken. The most important characteristic of the ratio scale is that it remains invariant over all transformations when multiplied or divided by a constant. That is the rank order of points on the scale, the ratios of points on the scale and the zero point are all unaffected by division or multiplication by a constant. Interval scales are also invariant under linear transformations and are unaffected when a constant is added to each value after being multiplied or divided by another constant.

Frequently in adult education research the fundamentalist view of Stevens' is ignored in the name of pragmatism and ordinal data is treated as though it had interval and ratio scale characteristics. Although there is support in the literature for such action[1,7] the breaking of assumptions underlying the theory of measurement ought not to be taken lightly. Although the question of the use of parametric and non-parametric tests in the literature is highly contentions there ought to be no questioning the wisdom of always striving to develop the highest levels of measurement possible. Generally interval and ratio scales are thought to be inescapably complex and tedious to construct, while nominal and ordinal scales are thought to be both easy to construct and acceptable by convention. For this reason alone many graduate students and researchers in the discipline do not devote more time to scale construction.

This study explores one means of constructing a ratio scale for use in an adult education study by a relatively simple psycho-physical scaling procedure known as magnitude estimation.

Magnitude Estimation

Originally developed by psycho-physicists to measure perceived increases in the magnitudes of such variables as loudness, brightness and heaviness magnitude estimation has been found to have utility in the quantification of social norms, opinions and attitudes. Examples of the successful application of magnitude estimation can be found in the diverse areas of aesthetic value of handwriting[3], seriousness of the offences of juvenile delinquents[9], the importance of Swedish monarchs[4], occupational prestige[8], and the magnitude of social re-adjustments or life changes[5,6].

The basis of the method rests on the human capability to match numbers to stimuli and stimuli to numbers in such a way as to accurately estimate ratios between stimuli and also to adjust stimuli to match prescribed ratios. The generally used procedure in magnitude estimation involves having the subject compare two stimuli presented simultaneously. One of the stimuli serves as a standard or referant and the subject estimates the magnitude of the two, or the ratio between the two stimuli. Subjects' responses can be obtained by the assigning of numbers, drawing lines of lengths proportional to the stimuli, squeezing hand grips, drawing circles or squares, increasing the magnitude of another stimulus, or by some other similar means. Stevens[13] refers to these procedures as direct methods of scaling, and to the Thurstonian procedures as indirect. The distinction is that with indirect methods respondents perform a minimum of quantification. Usually they are asked which of a pair of stimuli is the greater in terms of an observable characteristic. This data provides information to rank order the stimuli, and later

variability of judgements is superimposed on the ranks in order to distribute subjects along the scale continuum. With the direct method of magnitude estimation no psychometric assumptions are superimposed on the data at a later date. The respondents perform the quantification usually by assigning their own numerical value to the response. On many attitudinal continua Thurstonian scales generated by indirect methods have been found to have an invariant relation to the scale of magnitude developed by the direct methods of magnitude estimation.

In many experiments over the last thirty years it has been shown from the subjective estimations of observers plotted against the magnitudes of the stimuli observed, that there is a great deal of agreement between individuals' perceptions of magnitude. In fact man may have an innate psychological capacity for making quantitative judgements about psycho-physical phenomena. It has been suggested that these responses are non-voluntary at the psychological level, and it is also possible as Shinn[10] has speculated, that subjective responses to social stimuli may also be non-voluntary and that "the individual is in a sense a prisoner of his conditioned values." If such is the case the value placed on learning by an adult may be determined by his previous experiences as a learner. As many adults have shared similar experiences in formal instructional settings both as pre-adults and adults it is conceivable that there is a social consensus regarding the magnitude of learning that occurs in various activities. By quantifying these subjective estimates of learning it would be possible to assign "units of learning" to individuals participating in those activities indicating their exposure to or involvement in learning over a period

of time. If achieved, such measurement capability would allow research into the extent of an individual's commitment to learning and would be a major step beyond simply observing acts of participation which do not take into account relative differences in expected learning.

INSTRUMENT DEVELOPMENT

The Subjective Estimation of Adult Learning Scale (SEALS) was developed over a three year period. A total of 110 items for use in the scale were derived from adult education brochures, calendars, and circulars describing adult learning opportunities and from colleagues. The pool of items was used in several trial versions which were administered to adult education students and participants in a wide range of adult education activities. Item analyses were conducted and those items with very large standard deviations indicating disagreement between raters were rejected. During this process items were edited to ensure clarity, the duration of each of the activities was added to the form, directions to the respondents were modified and the values of the "standard" item were varied.

A modified form consisting of thirty-five items was tested with a sample of sixty vocational instructors and seventy-five adult education graduate students and yielded satisfactory results for the twenty-six items which now comprise the final form. The items include a range of credit, non-credit, vocational, general-interest, institutional and self-directed learning activities. A copy of the final form is attached.

Administration

The SEALS was administered to a convenience sample of participants in credit courses at the Vancouver Community College, students and faculty in the Department of Adult Education of the University of British Columbia and participants in the Vancouver School Board adult education program. Not all of the respondents fully completed the form and approximately 10 per cent of the college participants and 15 per cent of the school board participants gave responses which indicated that they did not understand the instructions on the form. The incomplete and inaccurate responses were rejected leaving 191 college respondents, 147 adult education students and faculty, and 165 school board respondents for a total of 503 completed forms.

At each administration of the form the respondents were given an explanation of the intent of the research and several examples of the rating procedure were presented prior to the form being distributed. The instructions on the form were read aloud and individuals were encouraged to ask questions and seek guidance on the procedure. There was no discussion of the actual scale items or the values to be placed on the items, and there was no discussion once the groups began to complete the forms. Approximately half of the adult education students responding had completed one or two of the developmental forms of the SEALS and were therefore skilled in this particular magnitude estimation technique.

In addition to responding to the 26 items on the form the respondents were asked to provide information on their sex, number of years of schooling completed and their age. Of the total number of

respondents 62.5 per cent were male and 37.5 per cent were female; 66.9 per cent had completed thirteen or more years of schooling, 26.6 per cent had completed nine to twelve years and 6.5 per cent had completed eight years or less of schooling. There was no significant difference between males and females by years of schooling completed ($x^2 = 4.26$) or by sex and age. ($x^2 = 4.05$). A summary of the characteristics of the respondents by sex, years of schooling and age is provided in Table 1.

TABLE 1

CHARACTERISTICS OF RESPONDENTS BY SEX, AGE AND YEARS OF SCHOOLING COMPLETED

		Years of Schooling Completed							
		<8 Yrs		9-12 Yrs		> 13 Yrs		Totals	
		No	%	No	%	No	%	No	%
Sex	Male	15	3.0	95	19.0	206	41.0	316	63.0
	Female	14	3.0	42	8.0	131	26.0	187	37.0
	Total	29	6.0	137	27.0	337	67.0	503	100.0
Age	< 24	0	0.0	74	14.8	185	37.0	259	51.8
	25-34	4	0.8	32	6.5	113	22.6	149	29.8
	35-44	9	1.8	17	3.5	26	5.2	52	10.4
	> 45	16	3.0	14	2.8	13	2.6	43	8.6
	Total	29	6.0	137	27.0	337	67.0	503	100.0

Results

The mean item scores produced by the 503 respondents are presented in Table 2. As recommended by Stevens[13] geometric means were calculated to establish the mean item values. Arithmetic means are also presented for purposes of comparison however as previous research has shown that the variability of magnitude estimations grows in proportion to the magnitude of the scores, geometric means are the most appropriate measure for averaging over subjects.

$$G_M = \sqrt[n]{X_1 \cdot X_2 \cdot X_3 \cdots X_n}$$

or

$$\log G_M = \frac{\log X_1 + \log X_2 + \cdots \log X_n}{N} .$$

The relationship between the geometric and arithmetic means can be clearly seen in Figure 1. Irregularities in the downward descent of the arithmetic mean curve identify deviations from the geometric mean ordering.

The initial striking feature of the results is the agreement between the three groups in terms of the ranking of the items by their geometric means. Spearman rank order correlation coefficients were computed to test the relationship of the rank orders between the groups. The coefficients obtained, all significant beyond the .01 level were college vs school board $r_s = 0.99$, college vs adult education $r_s = 0.99$, and school board vs adult education $r_s = 0.98$. The correlation between the rank order of items as they appeared on the form and the

TABLE 2

ARITHMETIC MEANS, GEOMETRIC MEANS AND GEOMETRIC MEAN RANKS BY INSTITUTIONAL AFFILIATION OF RESPONDENTS AND SCALE ITEMS

Original Item Number	Item	Community College N = 191			Adult Education Department N = 147			School Board N = 165			Totals N = 503		
		$\bar{A}$	$\bar{G}$	Rank	$\bar{A}$	$\bar{G}$	Rank	$\bar{A}$	$\bar{G}$	Rank	$\bar{A}$	$\bar{G}$	Rank
11	Apprenticeship	1025	495	1	929	439	1	1831	1119	1	1261	625	1
20	Vocational School Course	484	263	2	371	267	2	596	390	2	488	301	2
16	University Credit Course	294	219	3	265	226	3	338	282	3	300	240	3
9	University Credit Correspondence	251	182	4	230	187	4=	261	209	4	248	192	4
22	Community College Credit	201	162	5	215	187	4=	211	181	5	208	176	5
24	High School Credit	142	125	7	164	142	7	170	144	6	158	136	6
27	Short Vocational Credit Course	143	123	8	180	152	6	151	130	8	156	133	7
3	High School Credit Correspondence	165	126	6	178	141	8	166	133	7	169	132	8
13	Non-credit College	121	100	9=	104	96	12	115	106	9	114	101	9
1	Standard Item	100	100	9=	100	100	11	100	100	10	100	100	10
5	Non-credit Correspondence	131	97	11	144	114	9	123	90	11=	132	99	11
21	Recreation Centre Lessons	116	93	12	119	102	10	110	90	11=	115	95	12
10	Programmed Text	79	62	13	111	80	13	73	58	13	87	65	13
17	One Day Workshop	63	50	14	78	61	14	52	41	16	64	50	14=
4	Individual Lessons	83	55	15	76	44	17	81	49	14	80	50	14=
15	Read Non-fiction Book	66	51	16	71	49	15	59	44	15	65	48	16
23	Labour Union Short Course	65	44	17	60	45	16	49	35	17	58	41	17
14	Attended a One Day Convention	58	42	18	55	34	19	50	31	18	54	36	18
12	Read a News Magazine	51	35	19	60	42	18	48	30	19=	53	35	19
7	Guided Tour	52	34	20	49	32	21	48	30	19=	50	32	20
18	Educational TV Program	48	35	21	46	33	20	35	23	21	43	30	21
8	Taped Lecture	50	31	22	39	25	23=	36	22	22	42	26	22
26	Attended a Public Show	38	26	23=	39	26	22	30	19	24	35	24	23=
25	Attended a Public Lecture	36	26	23=	34	25	23=	32	20	23	34	24	23=
19	Read a Daily Newspaper	39	26	23=	37	25	23=	29	16	27	35	22	25
6	Attended a Union or Professional Meeting	30	20	27	31	21	26	29	17	25=	30	19	26
2	Listened to Educational Radio	35	23	26	23	15	27	26	17	25=	28	18	27

total group item ranks was not significant ($r_s = -0.047$).

Kendall's coefficient of concordance W was used to test the extent of agreement between respondents' rankings of the scale items within each of the three respondent groups. Unfortunately the computer program for Kendall's W was not capable of dealing with the total number of respondents simultaneously. The values of W obtained for each group indicated that the respondents assigned scores when used to rank the scale items resulted in consensus rankings. A high degree of agreement about the ordering of the items generated W coefficients significant beyond the .001 level for each group. (Community college W = 0.59 , adult education department W = 0.64, school board W = 0.66).

The item receiving the largest assigned units of learning was apprenticeship. The geometric mean score assigned to this item by the school board respondents (1,119) was over twice as high as that assigned to the item by college respondents(495) and by adult education department respondents(439). A similar pattern of responses was obtained for the six month vocational training course and the university credit course ranked second and third respectively. However, the size of the difference between the geometric group means was reduced from 100 per cent to 50 per cent and 25 per cent respectively with school board respondents producing a geometric mean of 390 for the vocational course and 282 for the university course, the college respondents' means were 263 and 219 and those of the adult education department 267 and 226 for the respective items.

As was expected items of longer duration received larger scores than did items of short duration ($r = 0.90$, $p < 0.001$). Credit courses received the highest ratings following apprenticeship and vocational training, with university credit having a geometric mean of 240 as compared to community college credit with 176 and high school credit with 136 all for a period of sixty hours duration. Study by correspondence at the university and high school credit levels were rated lower than corresponding regular credit activities even though one hundred hours of study time was allotted to them rather than sixty hours for the regular credit courses. A similar relationship held for the non-credit correspondence item. the magnitude of this difference between assigned units of learning was large for the university credit items with 240 as compared to 176 units, but relatively small

for the high school credit with 136 to 132 units and for the non-credit items 100 as compared to 99 units of learning.

Little difference was found between the ratings assigned general interest courses offered through a college(101) and a school district(100) and learning a hobby or recreational skill at a recreation centre(95). These three items had the same duration of twenty hours. The remaining items did not fall into any clear pattern of activities other than being structured individual and short duration formal activities including using a programmed text book(65), taking individual lessons(50), attending a one day workshop(50), reading a non-fiction book(47), and attending a short course given by a union or professional association(41). Finally, the remaining items consisted of activities involving the mass media with news and cultural magazines(36), educational television(30), reading a daily newspaper(22), and listening to a serious radio program(18) being closely ranked with "public" events such as attending a convention(35), taking a guided tour(32), attending a public exhibitionor show(24) and attending a union or a professional association meeting(19).

Although as previously mentioned course duration was correlated with the magnitude of the item means ($r = 0.90$, $p < .001$), this relationship is expressed without regard to the ratio between the duration of each activity and the assigned learning units. The number of units assigned per hour of learning activity, or the time-learning benefit ratio of each activity provides a different view of the data. Table 3 shows the items rank ordered by geometric mean number of units of learning assigned per hour of learning activity. Those items of shortest duration had the highest assigned learning units per hour, and

TABLE 3

ITEMS RANKED BY TIME-LEARNING UNITS RATIO

Rank	Item	$\bar{G}$	Duration (hours)	$\bar{G}$/Duration	$\bar{G}$ Rank
1	Read a News Magazine	35	1	35	19
2	Educational TV Program	30	1	30	21
3	Taped Lecture	26	1	26	22
4	Read a Daily Newspaper	22	1	22	25
5	Listened to Educational Radio	18	1	18	27
6	Guided Tour	32	2	16	20
7	Attended a Public Lecture	24	2	12	23=
8	Labour Union Short Course	41	4	10.2	17
9	Union or Professional Meeting	19	2	9.5	26
10	One Day Workshop	50	6	8.3	14=
11	One Day Convention	35	6	5.8	19
12=	Individual Lessons	50	10	5.0	14=
12=	Standard Item	100	20	5.0	10
12=	Non-credit College	101	20	5.0	9
15=	Read Non-fiction Book	48	10	4.8	16
15	Recreation Centre Lessons	95	20	4.7	12
17=	Attended a Public Show	24	6	4.0	23=
17=	University Credit Course	240	20	4.0	3
19	Short Vocational Credit Course	133	40	3.3	7
20	Programmed Textbook	65	20	3.2	13
21	Community College Credit	176	60	2.9	5
22	High School Credit	136	60	2.3	6
23	University Credit-Correspondence	192	100	1.9	4
24	High School Credit-Correspondence	132	100	1.32	8
25	Non-credit Correspondence	99	100	1.0	11
26	Vocational School Course	301	600	0.5	2
27	Apprenticeship	625	?	<0.5 (estimated)	1

the original ranking of items by geometric means is reversed.

An adequate explanation of this finding cannot be provided at this time. Several hypotheses might be advanced including the following: (1) The data confirms that immediacy of learning is highly valued by the adult and those activities which are intensive and of short duration are more highly rated learning experiences. (2) Adults see different learning activities in a qualitative sense, with immediate learning from the media and short term activities being judged differently from learning acquired through long-term activities. (3) The results are an artificial product of the data, respondents did not take duration into account but merely thought of the potential for learning in each item. (4) The respondents' perceptions of the value of time increased as the units of measurement decreased, conversely their judgements of the value of time in learning decreased as the time intervals increased. (5) The ability to adequately assess learning may decrease as the duration and possible complexity of the learning activity increases. (6) A combination of these factors may be contributing to the obtained results.

To test for the effects of sex, years of schooling and age on the estimates obtained for the total group an analysis of covariance was conducted using log estimates as the observations. A unbalanced 2 x 3 factorial design with age as the covariate was used with a general linear model BMD10V[14]. The results of the analysis are summarised in Table 4 .

TABLE 4

ANALYSIS OF COVARIANCE TABLE

	Source of Variance	Items $p < .05$	Items $p < .01$
1	Sex		11
2	Education	7, 15	9,10,11,16,20,21,27
3	Sex: Education		11
4	Covariate-Age	4,14,16,19	1,2,3,7,8,11,13, 15,17,18,20,25

The covariate age was a significant source of variance on sixteen of the twenty-six items tested, education was found to be significant with nine items, and sex and a sex-education interaction were significant on one item. Those items on which education was found to be a significant influence were with the exception of the taped lecture and the programmed textbook concerned with formal instructional activities. Respondents with more years of schooling completed tended to assign greater estimates of learning to the activities than did the respondents with fewer years of schooling completed.

Sex and an interaction between sex and education were significant sources of variance on the item, attendance at a one day convention. Females assigned higher units of learning to attending a convention than did males. Also the higher the number of years of schooling completed the higher the assigned units of learning by females, years of schooling

completed did not influence male respondents.

The subjects in the study were predominantly young, highly educated adults. Older respondents in the study tended to have completed fewer years of schooling than the younger respondents, and it is clear that if age had not been controlled in the study years of schooling would have had greater effects upon the results. Consistently throughout the SEALS younger respondents assigned higher units of learning to the items than did older respondents.

Reliability

Scale reliability was estimated using two methods test re-test and a cross-modal matching technique. Twenty-four graduate students in the department of adult education at the University of British Columbia completed the SEALS twice, with a one month interval between the two administrations. The Pearson product moment correlation coefficients obtained between individual's test and re-test responses for each item ranged from 0.51 to 0.68 and were significant beyond the .01 level. A coefficient of 0.79 was obtained between the arithmetic mean scores of the twenty-six items on the group's test re-test responses.

Seventeen doctoral students and faculty members of the adult education department responded to the SEALS in its regular form and one week later completed a second form which required lines to be drawn to indicate units of learning rather than the assignment of numbers. The standard item was presented with a line ten centimetres long. The order of the items remained the same, and space was left on the form

for lines to be drawn beneath each item. Respondents were asked to draw the lines free hand. If the length of their proposed lines exceeded the width of the form, which was printed on 8 1/2 x 14 inch paper, provision was made for additional lines to be drawn below the item. The measurements of the lines were recorded in millimetres. The maximum length of continuous line possible was 350 milimetres or 3.5 times the length of the standard. Test re-test correlation coefficients for each item ranged from 0.49 to 0.60 and were significant at the .05 level. A correlation coefficient of 0.66 significant at the .01 level was obtained between the test retest arithmetic means of the items.

The reliability of the scale was considered to be acceptable with the obtained correlation coefficients. However, it must be acknowledged that the respondents did have prior experience with the SEALS form in its developmental stages and they were familiar with the magnitude estimation technique. The utility of alternate means of assigning unit scores to the items was successfully demonstrated by the cross-modal matching technique.

Ratio Properties

Do the results obtained provide evidence that the SEALS actually constitutes a ratio scale?

Although the three groups of respondents studied do assign different magnitudes to the items, there is a large degree of agreement between respondents within the groups as to the rank order of the items, and the differences in magnitudes assigned between the groups are major only with respect to three items.

A concensus regarding the subjective estimation of learning in the activities described influenced by years of schooling completed and age does appear to exist.

One major similarity between the groups can be seen in the distribution of the ratios of the geometric mean scores and the arithmetic mean scores for each item when plotted against the arithmetic mean item scores as shown in Figures 2-5. These distributions are almost identical in shape to that reported by Masuda and Holmes[6] in the development of a ratio scale of life change events. The distributions indicate that as judgemental variance increases with the magnitude of the estimates it increases proportionally and linearly to the increase in estimates. Such a relationship according to Masuda and Holmes[6] supports the general scientific law of relative variability and contributes to the validity of subjective magnitude estimation procedures being used in psycho-social measurement. The two highest ranking items apprenticeship and vocational training have mean ratios which deviate from the ratios of other high ranking items. This observation suggests that the reliability of the two items in terms of their ratio scale properties may be open to doubt.

The relationship between the standard errors of the geometric mean and the geometric mean item scores is shown in Figure 6. This linear relationship ($r = 0.98$) supports the principle of measurement that variability in scores is a function of the magnitude of the scores, and as such is evidence of the scalable nature of the data.

Stevens[13] reports that indirect scaling by paired comparisons produces a scale which is a logarithmic function of the magnitude estimation scale. Since twenty-seven items create 251 different paired items, this final step in the examination of the ratio properties of the SEALS presented major judging and computation difficulties. Future research is being planned to reduce the number of scale items and to use an item sampling procedure to test the relationship between direct and indirect scaling of the SEALS.

CONCLUSION

The development of a ratio scale measuring subjective estimates of adult learning described in this paper demonstrates that the psychophysical scaling technique of magnitude estimation has utility for the quantification of variables in adult education. Although a definition of learning was not provided for the respondents, their responses based on their own understanding of the construct indicates that a consensus regarding subjective estimates of learning may exist. It is recognized that further research with the SEALS needs to be undertaken in order to ascertain the variability of estimates contributed by respondents' personal experience, or lack of it, as learners in each of the twenty-seven scale activities and socio-economic characteristics including occupation, income, age and level of education. Application of the scale in communities outside the Vancouver Metropolitan Area is also desirable. In addition a comparison of the results obtained from a Thurstonian paired comparisons procedure and the SEALS needs to be undertaken in the future to provide conclusive evidence of the existence of ratio scale characteristics.

The application of magnitude estimation techniques to the quantification of variables related to motivation; learning needs; attitudes towards adult education methods and techniques; evaluation of program outcomes; setting priorities or goals for groups; barriers to participation; and teaching-learning styles among others, may yield reliable and valid ratio scales of measurement where presently only ordinal and

questionable interval scales exist. Samples of the size used in this study may not always be required, and frequently are not utilized by psycho-physicists. In fact one of the areas where magnitude estimiation may be of greatest use in the discipline of adult education is in an area of relative neglect, the conduct of small experimental studies in controlled learning environments. Alternatives to the traditional pencil and paper testing procedures exist with magnitude estimation and with imagination researchers in the discipline may apply those alternatives to many quantification problem areas in adult education research.

Direct rather than indirect scaling procedures appear to offer many advantages to adult education researchers. Their adoption would enable researchers in the discipline to engage in more sophisticated data analyses without breaking the assumptions of the tests being applied, and they should yield time-saving benefits as they are based on relatively simple procedures in both their development and their application.

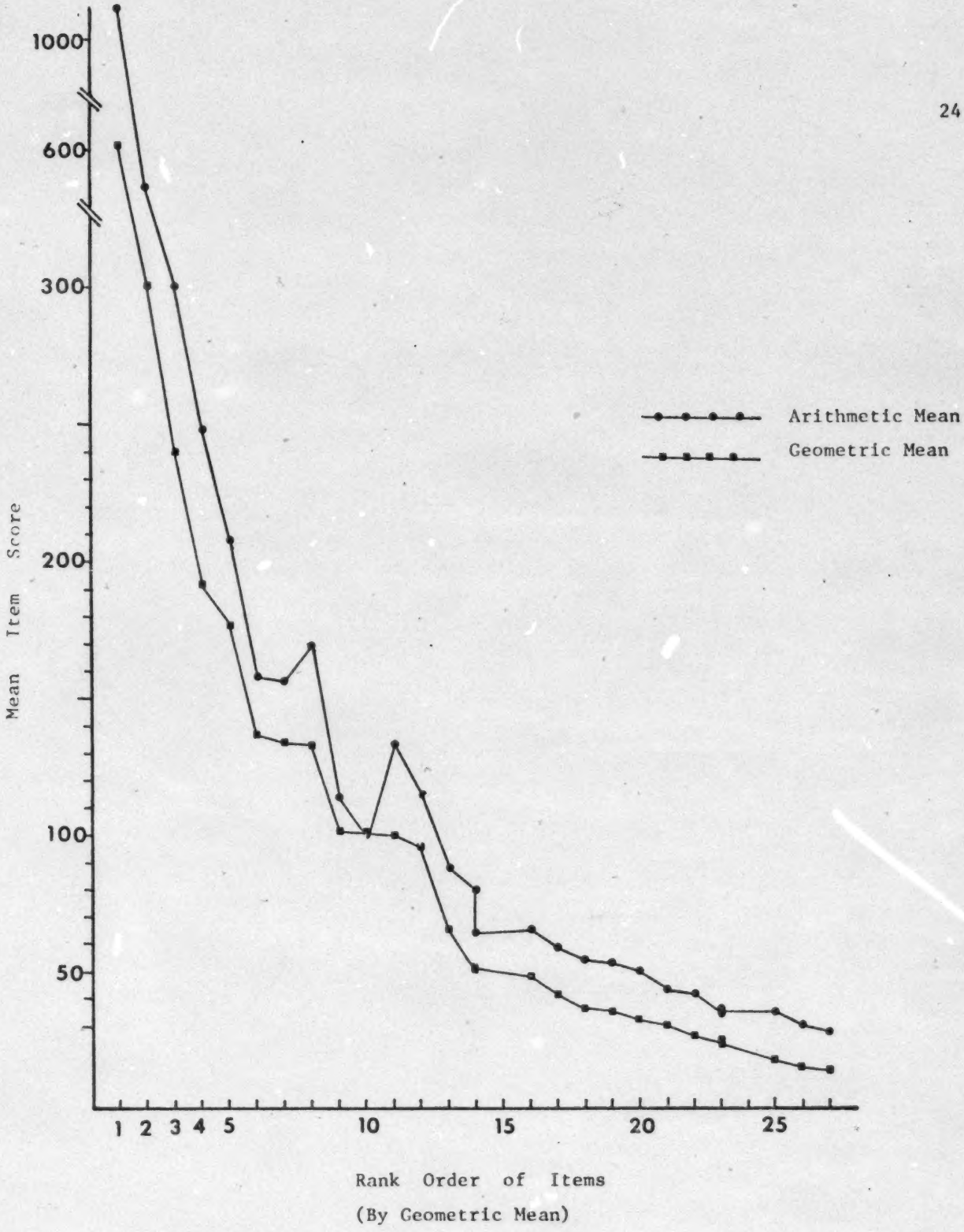


Figure 1 Geometric and Arithmetic Mean Item Magnitudes. Ranked by Geometric Mean

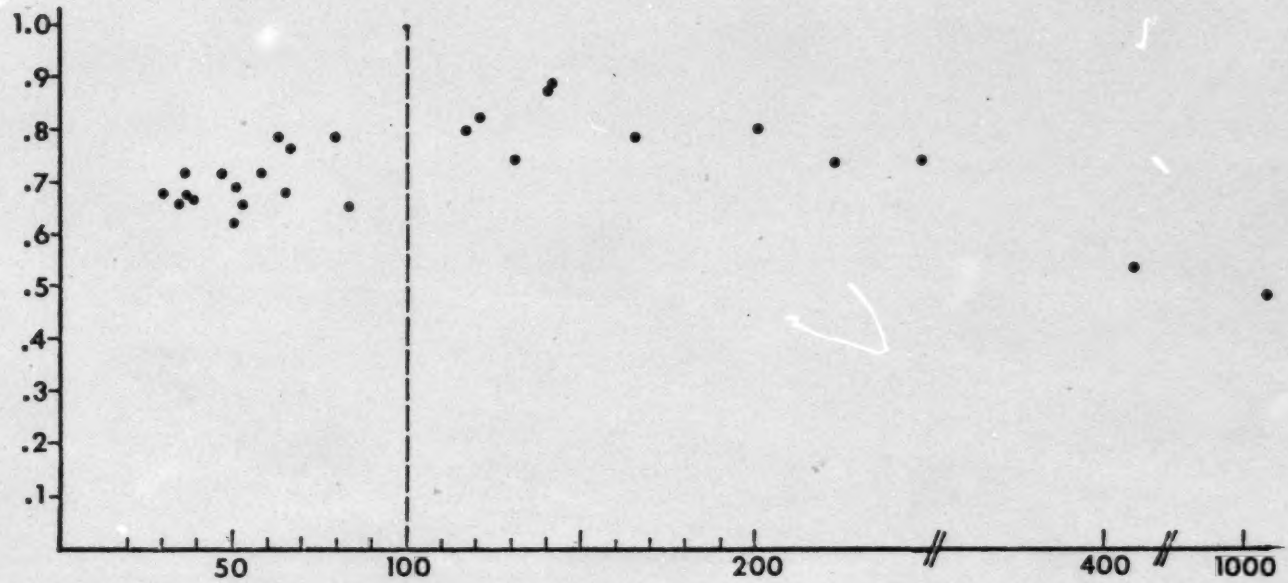


Figure 2 Community College Respondents n = 191

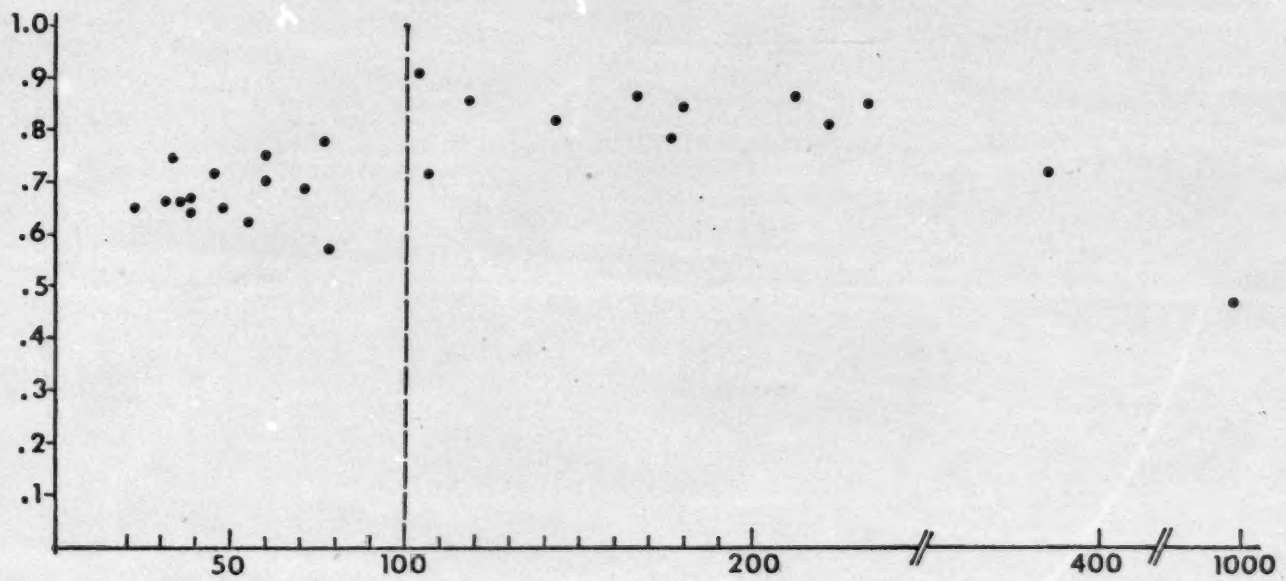


Figure 3 Adult Education Department Respondents n = 147

RELATIONSHIP OF RATIO OF GEOMETRIC AND ARITHMETIC MEANS AND ARITHMETIC MEAN ESTIMATES OF MAGNITUDE

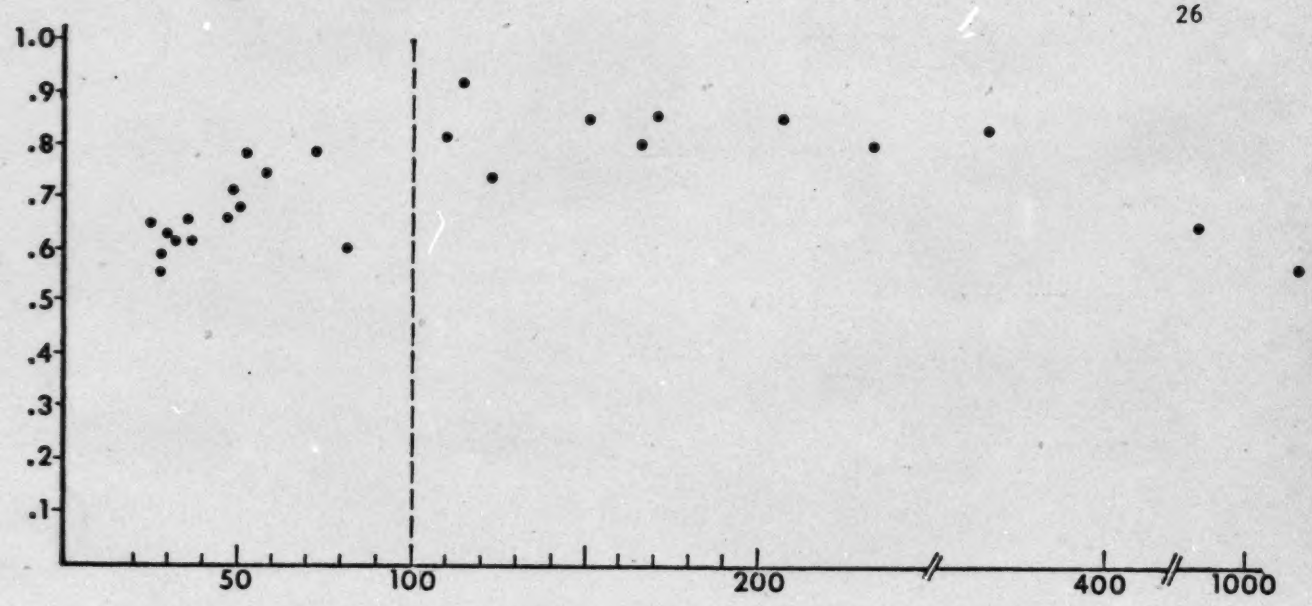


Figure 4 School Board Respondents n = 165

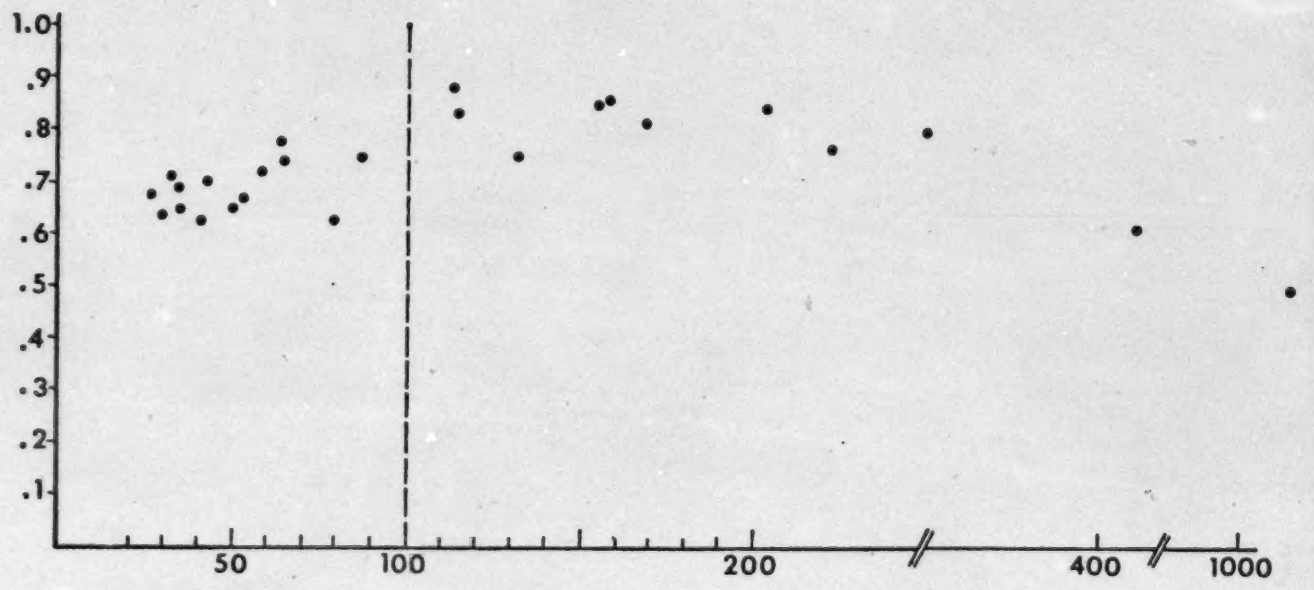
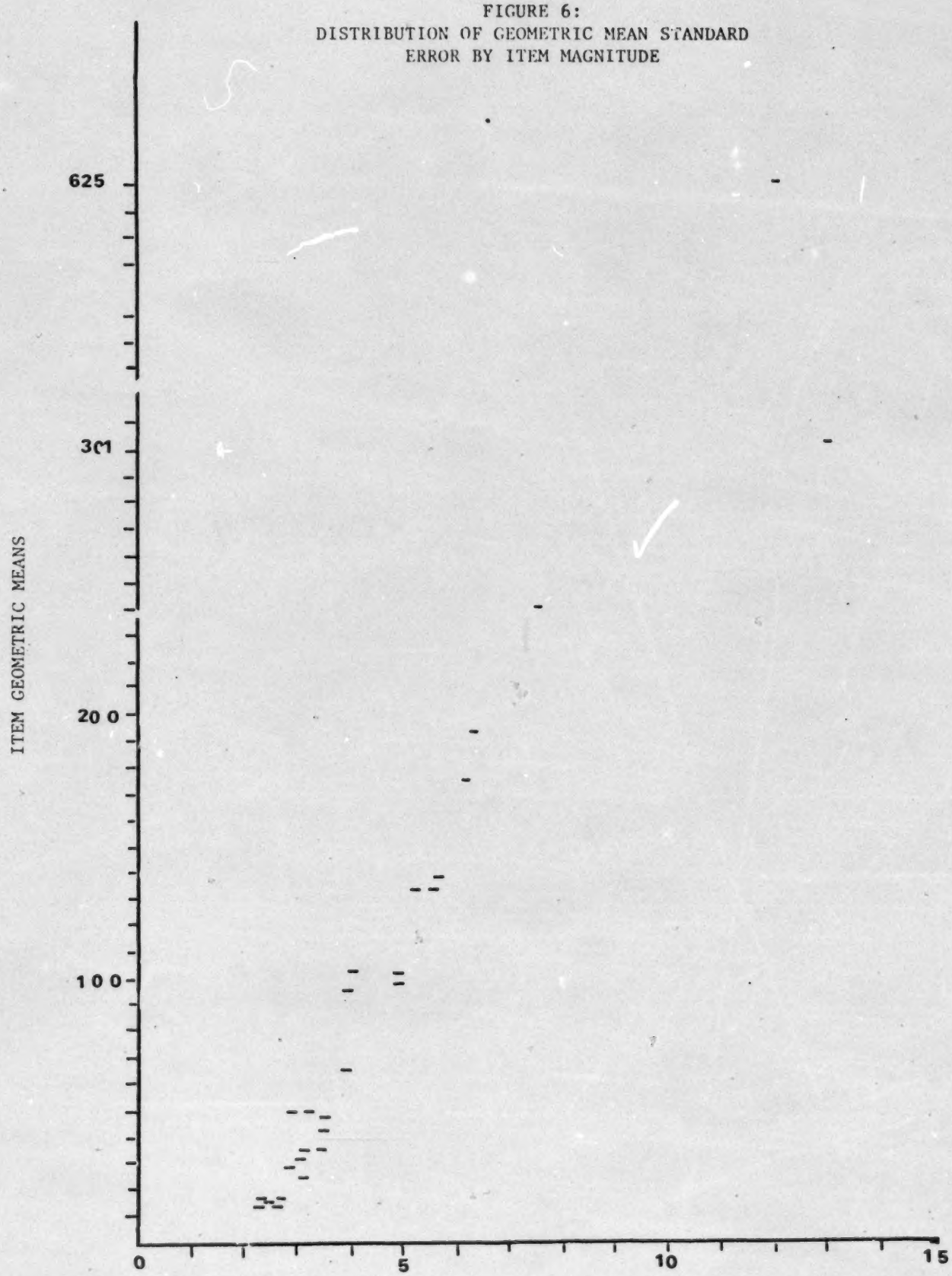


Figure 5 Total Respondents n = 503

FIGURE 6:
DISTRIBUTION OF GEOMETRIC MEAN STANDARD
ERROR BY ITEM MAGNITUDE



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Subjective Estimation of Adult Learning Scale

We are attempting to find out how much learning people think will occur in various types of activities. Would you please judge each of the twenty-six activities listed in the following two pages in terms of the amount of learning that you would normally expect to occur

As a basic unit for comparison we have described a *standard* for you to apply your judgements against. Think of attendance at a *non-credit, school district adult education course* such as automotive tune-up, wood-carving, pottery, French conversation or English improvement (10 weeks - 2 hours per week) as resulting in 100 units of learning. Using the *standard* described, assign the number of units of learning you think will occur in each of the activities listed.

The number of units you choose to assign may be considerably greater, or considerably less than 100. The number should be based upon the *average amount of learning that you would normally expect to occur* in each activity. The number of units you assign could range from 0 (no learning expected) to 500 (five times more learning) or even higher. *There are no upper limits to the number of units you can assign.*

For example, if you think that thoroughly reading a daily newspaper is an activity that results in only one-fifth as much learning as the *standard*, that is the non-credit, school district adult education class, you would assign one-fifth of the standard's 100 units which is 20 to reading the newspaper.

Example:		Units of Learning
Standard:	Took a *non-credit, school district adult education course* such as automotive tune-up, wood carving, pottery, French conversation, or English improvement. (10 weeks - 2 hours per week).	100
Activity:	Thoroughly read a major daily newspaper.	20

... Please Turn Over ...

	Units of Learning
Standard: Took a *non-credit, school district adult education course* such as automotive tune-up, wood-carving, pottery, French conversation or English improvement (10 weeks - 2 hours per week).	100
1. Listened to *a serious or educationally valuable* radio program such as "Cross Country Check Up," or "As It Happens." (1 Hour)	___
2. Took a *high school credit* course by correspondence. (100 Hours)	___
3. Had *individual lessons or tutoring* to develop a recreational or hobby skill such as tennis, swimming or music lessons. (10 Hours)	___
4. Completed a *non-credit* general interest course of study by correspondence. (100 Hours)	___
5. Attended a labour Union, professional association or community group meeting. (2 Hours)	___
6. Took a *guided tour or educational visit* to an art gallery, museum, factory, industrial plant or institution such as a hospital or armed forces base. (2 Hours)	___
7. Listened to a *teaching tape or record* on subjects such as learning a foreign language, or improving one's job performance. (1 Hour)	___
8. Completed a *university credit* course by correspondence. (100 Hours)	___
9. Worked through a *programmed instruction text book* such as a "how to do it," or "teach yourself" book on car mechanics, bookkeeping or macrame. (20 Hours)	___
10. Served an *apprenticeship*. (6 months full time at vocational school and two years indentured to an employer).	___
11. Attended a *one day convention* or professional association annual meeting. (6 Hours)	___
12. Took a *community college non-credit* course such as learning a foreign language, decorating your own home, basic carpentry, or English upgrading. (10 weeks - 2 Hours per week)	___
13. *Thoroughly read* a news or cultural magazine such as Time, Newsweek, Reader's Digest or Macleans. (1 Hour)	___

Please Turn Over

	Units of Learning
Standard: Took a *non-credit, school district adult education course* such as automotive tune-up, wood-carving, pottery. French conversation, or English improvement. (10 weeks - 2 Hours per week)	100
14. Read a *serious, non-fiction* book of your own, borrowed from a library, a friend, or from any other source (10 Hours)	___
15. Took a *university credit course* - other than by correspondence. (20 weeks - 3 Hours per week)	___
16. Attended a *one-day workshop or educational course* on any subject. (6 Hours)	___
17. Watched a *serious or educationally valuable* television program such as the "National Geographic" series, The "Ascent of Man," "Newsweek" or "W5". (1 Hour)	___
18. *Thoroughly read* a major daily newspaper. (1 Hour)	___
19. Took a *provincial vocational school* training course. (6 months full time)	___
20. Took a course at a *recreation centre* to learn a recreational or hobby skill such as tennis, skating, golf, bridge, pottery or painting. (10 weeks - 2 Hours per week)	___
21. Took a *college-level, credit course* at a community college - other than by correspondence. (20 weeks - 3 Hours per week)	___
22. Attended a *short training course* offered by a labour union or a professional association. (2 weeks - 2 Hours per week)	___
23. Completed a *high school-level credit course* given by a school district adult education department. (20 weeks - 3 Hours per week)	___
24. Attended a public lecture - Not a political meeting. (2 Hours)	___
25. Spent a day at an automobile, agricultural, house or boat show. (6 Hours)	___
26. Took a short, *part-time vocational course for credit* toward a trade certificate, such as electrical codes, welding, typing, or air brake operation. (10 weeks - 4 Hours per week)	___